BS EN 61260-2:2016

BSI Standards Publication

Electroacoustics — Octave-band and fractional-octave-band filters

Part 2: Pattern-evaluation tests

bsi.

National foreword

This British Standard is the UK implementation of EN 61260-2:2016. It is identical to IEC 61260-2:2016. Together with BS EN 61260-1:2014 and BS EN 61260-3:2016, it supersedes BS EN 61260:1996 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee EPL/29, Electroacoustics.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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English Version

Electroacoustics - Octave-band and fractional-octave-band filters - Part 2: Pattern-evaluation tests (IEC 61260-2:2016)

Electroacoustique - Filtres de bande d'octave et de bande d'une fraction d'octave - Partie 2: Essais d'évaluation d'un modèle (IEC 61260-2:2016)

Elektroakustik - Bandfilter für Oktaven und Bruchteile von Oktaven - Teil 2: Baumusterprüfung (IEC 61260-2:2016)

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

European foreword

The text of document 29/845/CDV, future edition 1 of IEC 61260-2, prepared by IEC TC 29, Electroacoustics, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61260-2:2016.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2017-01-27
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2019-04-27

This document supersedes EN 61260:1995.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 61260-2:2016 was approved by CENELEC as a European Standard without any modification.

Annex ZA

(normative)

Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 61000-4-2	2008	Electromagnetic compatibility (EMC) -- Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test	EN 61000-4-2	2009
IEC 61000-4-3	2006	Electromagnetic compatibility (EMC) -- Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test	EN 61000-4-3	2006
IEC 61000-4-6	2013	Electromagnetic compatibility (EMC) -- Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields	EN 61000-4-6	2014
IEC 61000-6-1	-	Electromagnetic compatibility (EMC) -- Part 6-1: Generic standards - Immunity for residential, commercial and light-industrial environments	EN 61000-6-1	-
IEC 61000-6-2	2005	Electromagnetic compatibility (EMC) -- Part 6-2: Generic standards - Immunity for industrial environments	EN 61000-6-2	2005
-	-		+ corrigendum Sep.	2005
IEC 61000-6-3	-	Electromagnetic compatibility (EMC) -- Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments	EN 61000-6-3	-
IEC 61260-1	2014	Electroacoustics - Octave-band and fractional-octave-band filters -- Part 1: Specifications	EN 61260-1	2014
IEC 61672-1	-	Electroacoustics - Sound level meters -- Part 1: Specifications	EN 61672-1	-
ISO/IEC Guide 98-3	-	Uncertainty of measurement - Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)	-	-
ISO/IEC Guide 98-4	-	Uncertainty of measurement_- Part_4: Role of measurement uncertainty in conformity assessment	-	-
ISO/IEC Guide 99	-	International vocabulary of metrology - Basic and general concepts and associated terms (VIM)	-	-
CISPR 16-1-1	-	Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-1: Radio disturbance and immunity measuring apparatus - Measuring appartus	-	-
CISPR 16-1-2	-	Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-2: Radio disturbance and immunity measuring apparatus - Coupling devices for conducted disturbance measurements	EN 55016-1-2	-

CISPR 16-2-1	-	Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-1: Methods of measurement of disturbances and immunity - Conducted disturbance measurements	EN 55016-2-1	-
CISPR 16-2-3	-	Specification for radio disturbance and immunity measuring apparatus and methods -- Part 2-3: Methods of measurement of disturbances and immunity - Radiated disturbance measurements	EN 55016-2-3	-
CISPR 22	-	Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement	EN 55022	-

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROACOUSTICS – OCTAVE-BAND AND FRACTIONAL-OCTAVE-BAND FILTERS –

Part 2: Pattern-evaluation tests

FOREWORD

International Standard IEC 61260-2 has been prepared by IEC technical committee 29: Electroacoustics.

This first edition of IEC 61260-2 (together with IEC 61260-1:2014 and IEC 61260-3:2016), cancels and replaces the first edition of IEC 61260 published in 1995 and its Amendment 1 published in 2001. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to IEC 61260.

a) The single document in the first edition of IEC 61260:1995 is now separated into three parts of the IEC 61260 series covering: specifications, pattern-evaluation tests and periodic tests.
b) IEC 61260:1995 specified three performance categories: class 0, 1 and 2 while the IEC 61260 series specifies requirements for class 1 and 2.
c) In IEC 61260:1995, the design goals for the specification can be based on base-2 or base-10 design. In the IEC 61260 series only base-10 is specified.

d) The reference environmental conditions have been changed from 20 °C/65 % RH to 23 °C/50 % RH;
e) IEC 61260:1995 specified tolerance limits without considering the uncertainty of measurement for verification of the specifications. The IEC 61260 series specifies acceptance limits for the observed values and maximum-permitted uncertainty of measurements for laboratories testing conformance to specifications in the standard.

The text of this standard is based on the following documents:

CDV	Report on voting
29/845/CDV	29/881A/RVC

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all the parts of the IEC 61260 series, published under the general title *Electroacoustics – Octave-band and fractional-octave-band filters* can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

IEC 61260:1995 and IEC 61260:1995/AMD 1:2001 are now separated into the following three parts of IEC 61260 series:

- Part 1: Specifications
- Part 2: Pattern-evaluation tests
- Part 3: Periodic tests

For assessments of conformance to performance specifications, IEC 61260-1 uses different criteria than were used for the IEC 61260:1995 edition.

IEC 61260:1995 did not provide any requirements or recommendations to account for the uncertainty of measurement in assessments of conformance to specifications. This absence of requirements or recommendations to account for uncertainty of measurement created ambiguity in determinations of conformance to specifications for situations where a measured deviation from a design goal was close to the limit of the allowed deviation. If conformance was determined based on whether a measured deviation did or did not exceed the limits, the end-user of the octave-band and fractional-octave-band filters incurred the risk that the true deviation from a design goal exceeded the limits.

To remove this ambiguity, IEC Technical Committee 29, at its meeting in 1996, adopted a policy to account for measurement uncertainty in assessments of conformance in International Standards that it prepares.

This edition of IEC 61260-2 uses an amended criterion for assessing conformance to a specification. Conformance is demonstrated when (a) measured deviations from design goals do not exceed the applicable *acceptance limits* and (b) the uncertainty of measurement does not exceed the corresponding maximum-permitted uncertainty. Acceptance limits are analogous to the tolerance limits allowances for design and manufacturing implied in the IEC 61260:1995.

Actual and maximum-permitted uncertainties of measurement are determined for a coverage probability of 95 %. Unless more specific information is available, the evaluation of the contribution of a specific filter or filter set to a total measurement uncertainty can be based on the acceptance limits and maximum-permitted uncertainties specified in this standard.

ELECTROACOUSTICS – OCTAVE-BAND AND FRACTIONAL-OCTAVE-BAND FILTERS –

Part 2: Pattern-evaluation tests

1 Scope

1.1 This part of IEC 61260 provides details of the tests necessary to verify conformance to all mandatory specifications given in IEC 61260-1:2014 for octave-band and fractional-octave-band filters.

1.2 Tests and test methods are applicable to class 1 and class 2 bandpass filters. The aim is to ensure that all testing laboratories use consistent methods to perform pattern-evaluation tests.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-6:2013, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-6-1, *Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity for residential, commercial and light-industrial environments*

IEC 61000-6-2:2005, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments*

IEC 61000-6-3, *Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission standard for residential, commercial and light-industrial environments*

IEC 61260-1:2014, *Electroacoustics – Octave-band and fractional-octave-band filters – Part 1: Specifications*

IEC 61672-1, *Electroacoustics – Sound level meters – Part 1: Specifications*

CISPR 16-1-1, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus*

CISPR 16-1-2, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-2: Radio disturbance and immunity measuring apparatus – Coupling devices for conducted disturbance measurements*

CISPR 16-2-1, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements*

CISPR 16-2-3, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements*

CISPR 22:2008, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*

ISO/IEC Guide 98-3, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

ISO/IEC Guide 98-4, *Uncertainty of measurement – Part 4: Role of measurement uncertainty in conformity assessment*

ISO/IEC Guide 99, *International vocabulary of metrology – Basic and general concepts and associated terms (VIM)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61260-1:2014, IEC 61000-4-2, IEC 61000-4-3, IEC 61000-6-1, IEC 61000-6-2, and IEC 61000-6-3, ISO/IEC Guide 98-3, ISO/IEC Guide 98-4 and ISO/IEC Guide 99 apply.

4 Submission for testing

4.1 At least three specimens of the same pattern of bandpass filter shall be submitted for pattern-evaluation testing. As a minimum, the testing laboratory shall select two of the specimens for testing. At least one of the two specimens shall then be tested fully according to the procedures of this standard. The testing laboratory shall decide whether the full tests shall also be performed on the second specimen or whether limited testing is adequate to approve the pattern.

4.2 An instruction manual and all items or accessories that are identified in the instruction manual as integral components for the normal mode of operation shall be submitted along with the filters.

4.3 If the manufacturer of the filters supplies devices that are to be connected to the bandpass filter by cables for a typical mode of operation for the filter, then the devices and cables shall be submitted with the filter.

5 Marking of the filter and information in the instruction manual

5.1 It shall be verified that the filter is marked according to the requirements of IEC 61260-1:2014.

5.2 It shall be verified that the instruction manual contains all the information that is required by IEC 61260-1:2014 as relevant to the facilities provided by the filter.

5.3 If the filter does not conform to the requirements of 5.1 and 5.2, no pattern-evaluation tests shall be performed.

5.4 After completion of all tests, the information shall be reviewed to ensure that it is correct and that no applicable acceptance limits are exceeded.

6 Mandatory facilities and general requirements

6.1 General

6.1.1 No test specified in this part of IEC 61260 series shall be omitted unless the bandpass filter does not possess the feature described for the test. When the design of a fractional-octave-band filter, which has been pattern approved, is changed and a new pattern approval is requested, then – at the discretion of the testing laboratory – it is not necessary to repeat those tests for performance characteristics that are not affected by the design change.

6.1.2 If the filter does not possess the mandatory features listed in IEC 61260-1:2014, such as overload indicator or means to check that the power supply is adequate for battery powered instruments which contain the filter, the filter does not conform to the specifications of IEC 61260-1:2014, and no pattern-evaluation tests shall be performed.

6.1.3 For all pattern-evaluation tests, the configuration of the filter shall be as specified in the instruction manual for one of the normal modes of operation, including required accessories. All configurations of the filter that are stated in the instruction manual as conforming to the requirements of IEC 61260-1:2014 shall be tested.

6.1.4 If the instruction manual states that the filter conforms to the specifications of IEC 61260-1:2014 with optional facilities installed, the combination with the optional facilities installed shall also be tested to verify conformance to the relevant specifications.

6.1.5 If the filter is enclosed in an instrument containing a level detector and a display device for displaying the level of the filtered signal with a resolution of at least 0,1 dB, the displayed value from this display device shall be used for testing, if appropriate. If an electrical output is provided corresponding to the displayed value and the testing laboratory intends to utilize the electrical output instead of the display device, the laboratory shall verify that changes in the levels of applied electrical input signals produce corresponding changes in the signal levels indicated on the display device and at the electrical output that are in accordance with the specifications of IEC 61260-1:2014.

6.1.6 For bandpass filters that are designed to operate with measuring devices that comply with the requirements for sound level meters as specified in IEC 61672-1, the display indicator of this device shall be used to measure the level of the output signal from the filter set.

6.1.7 For filter sets with digital readout devices, or with output that is available in a manufacturer-specified digital format (for example over a digital interface connection), the level of the output should be determined from the numeric readout or via the digital output to a suitable display or recording device. Where multiple outputs are present, if an output is specified in the instruction manual for testing, this output shall be used for the pattern-evaluation tests.

6.1.8 If the instruction manual specifies a procedure for adjusting the filter, e.g. sensitivity adjustment, this procedure shall be followed before any measurements are performed.

6.1.9 For all tests, the filter shall be powered from its preferred supply. If the instruction manual specifies requirements for the internal batteries, such batteries shall be installed for the pattern-evaluation tests.

6.1.10 The filter shall be allowed to reach equilibrium with the prevailing environmental conditions before switching on the power to perform a test.

6.1.11 If the filter has more than one signal-processing channel, pattern-evaluation tests shall be performed for each channel that utilizes unique signal processing techniques. For multi-channel systems with the same functional equivalence in all channels, the number of channels to be tested may be less than the total number of channels, at the discretion of the testing laboratory.

6.1.12 Conformance to a performance specification is demonstrated when the following criteria are both satisfied:

a) the measured deviation from the design goal does not exceed the applicable acceptance limit and;
b) the corresponding uncertainty of measurement does not exceed the corresponding maximum-permitted uncertainty of measurement given in IEC 61260-1:2014 for the same coverage probability of 95 %.

IEC 61260-1:2014 gives example assessments of conformance using these criteria.

6.1.13 Laboratories performing pattern-evaluation tests shall calculate all uncertainties of measurements in accordance with the guidelines given in the ISO/IEC Guide 98-3. Actual measurement uncertainties shall be calculated for a coverage probability of 95 %. Calculation of the actual measurement uncertainty for a particular test should consider at least the following components, as applicable:

- the uncertainty attributed to calibration of the individual instruments and equipment used to perform the test;
- the uncertainty resulting from environmental effects;
- the uncertainty resulting from errors that may be present in the applied signals;
- the uncertainty attributed to effects associated with the repeatability of the results of the measurements. When a laboratory is only required to perform a single measurement, it is necessary for the laboratory to make an estimate of the contribution of random effects to the total uncertainty. The estimate should be determined from an evaluation of several measurement results previously obtained for a similar filter and parameter;
- the uncertainty associated with the resolution of the display device used to display the response from the filter. For digital display devices that indicate signal levels with a resolution of 0,1 dB, the uncertainty component should be taken as a rectangular distribution with semi-range of 0,05 dB.

6.1.14 If the uncertainty of measurement exceeds the maximum-permitted uncertainty of measurement, the result of the test shall not be used to demonstrate conformance to a specification, and pattern approval shall not be granted.

6.1.15 As appropriate, the laboratory shall utilize the recommendations given in the instruction manual for performing the pattern-evaluation tests.

6.2 Test instruments

6.2.1 The laboratory shall use instruments with valid calibrations for the appropriate quantities. The calibrations shall be traceable to national standards, as required.

6.2.2 Most of the required tests utilize steady sinusoidal signals of various frequencies and signal levels. Sinusoidal signals for test of filter attenuation shall have a total distortion of not more than 0,01 % for class 1 filters and not more than 0,03 % for class 2 filters. The total distortion for sinusoidal signals for other tests shall not exceed 0,1 %.

6.2.3 Tests for time invariant operation use a constant amplitude sinusoidal signal the frequency of which is varied, or swept, at an exponential rate. The effect on the deviation of the measured time-averaged output signal level from the uncertainty in the amplitude and sweep-rate for the determination of time-invariant operation shall be determined. The expanded uncertainty shall not exceed the values given in IEC 61260-1:2014, Annex B.

NOTE The informative Annex A gives examples of how such uncertainties may be obtained.

6.2.4 Instruments for measuring the environmental conditions during the tests shall have an expanded uncertainty not exceeding 0,5°C for temperature and 3 % for humidity.

7 Tests at reference conditions

7.1 General

7.1.1 All tests at reference conditions except test for electromagnetic and electrostatic compatibility shall be made within the temperature range 20 °C to 26 °C and within the range for relative humidity 35 % to 65 %.

7.1.2 The filter shall be permitted to acclimatize at the reference environmental condition for at least 6 h.

7.1.3 The measured values of temperature and humidity shall be extended with the actual expanded uncertainty of measurement and shall not exceed the specified range. It is assumed that the influence from changes in the atmospheric pressure is insignificant compared to the sensitivity to other environmental parameters. If this is not the case, the observation shall be reported.

7.2 Relative attenuation, effective bandwidth deviation and summation of output signals

7.2.1 General

7.2.1.1 The measurement of relative attenuation, effective bandwidth deviation and summation of output signals are made by the same set of measurements using the response to constant amplitude sinusoidal signals at various frequencies.

7.2.1.2 The measurement shall be performed on the reference level range. The level of the input signals shall be (1 ± 0,1) dB below the specified upper boundary of the linear operating range.

7.2.1.3 With the input and output of the instrument terminated, if appropriate, with the impedances specified by the manufacturer, a steady sinusoidal signal is applied to the input of the filter set. The relative attenuation at appropriate frequencies is measured.

7.2.1.4 The frequencies of the sinusoidal test signal for one filter are spaced at equal intervals on a logarithmic scale centred on the exact midband frequency. If S is the number of test frequencies per filter bandwidth, the normalized frequency Ω_i of the i-th test signal is determined from:

$$\Omega_i = G^{\frac{i}{b \cdot S}} \tag{1}$$

where

i is a positive or negative integer, including zero. The number of test frequencies per filter bandwidth, S, shall be not less than 24. G and b are, as defined in IEC 61260-1:2014, the octave frequency ratio and the inverse of the bandwidth designator.

NOTE If the filter consists of a set of filters operating in parallel (real time analysers), it will normally be suitable to measure the response to a particular frequency for all filter bands simultaneously and store the result for further calculations.

7.2.2 Relative attenuation

7.2.2.1 The relative attenuation $\Delta A(\Omega)$ at any frequency is determined from Formula (8) given in IEC 61260-1:2014. The measured relative attenuation shall not exceed the acceptance limits given in section 5.10 of the same standard.

7.2.2.2 The relative attenuation shall be measured from 0,5 times the exact midband frequency of the filter in the set with the lowest midband frequency, to 1,5 times the midband frequency of the filter in the set with the highest midband frequency.

7.2.2.3 Deviation between actual and requested frequency shall be considered when stating the uncertainty for testing of relative attenuation.

7.2.3 Effective bandwidth deviation

7.2.3.1 The effective bandwidth, B_e, shall be determined from Formulas (13) and (14) given in IEC 61260-1:2014, based on numerical evaluation of the integral expression in Formula (14) of the same standard for normalized effective bandwidth.

7.2.3.2 For each filter in a filter set, the recommended procedure for numerical integration of Formula (14) of IEC 61260-1:2014 is by the trapezoidal rule for summation of elemental areas according to:

$$B_\mathrm{e} = \sum_{i=-N}^{N} \left(\frac{2}{\Omega_i + \Omega_{i+1}} \right) \frac{1}{2} \left[10^{-0,1\Delta A(\Omega_i)} + 10^{-0,1\Delta A(\Omega_{i+1})} \right] \left[\Omega_{i+1} - \Omega_i \right] \qquad (2)$$

where

$\Delta A(\Omega_i)$ is the relative attenuation in decibels measured at the i-th normalized test frequency;

N is an integer equal to or greater than 2 × S for any filter bandwidth and accuracy class as long as the frequencies are within the limits in 7.2.2.2.

7.2.3.3 The measured effective bandwidth deviation shall not exceed the acceptance limits given in 5.12 in IEC 61260-1:2014.

7.2.4 Summation of output signals

7.2.4.1 Let j identify a filter in a set of filters with j-1 and j+1 representing the contiguous filters with midband frequencies lower and higher than for the j-th filter. Let ΔA_j, ΔA_{j-1} and ΔA_{j+1} represent measured relative attenuations of the three filters, respectively, at any test frequency.

7.2.4.2 With S equal to the number of test frequencies per filter bandwidth from the relative attenuation tests, let M be equal to the largest integer just less than or equal to S/2 and let i be any integer between $-M$ and $+M$ to determine a frequency for a measurement of relative attenuation.

7.2.4.3 At any normalized frequency, $\Omega_i = f_i / f_\mathrm{m} = G^{\frac{i}{b \cdot S}}$, between the lower and upper bandedge normalized frequencies of the j – th filter with exact midband frequency, f_m, the difference $\Delta P_j(\Omega_i)$ between the input signal level minus the reference attenuation and the level of the summed output signals is determined from the relationship:

$$\Delta P_j(\Omega_i) = 10 \lg \left[10^{-0,1\Delta A_{j-1}} + 10^{-0,1\Delta A_j} + 10^{-0,1\Delta A_{j+1}} \right] \text{ dB} \qquad (3)$$

where

ΔA_{j-1} is the relative attenuation measured for filter (j – 1) at normalized frequency for that filter $G^{[i/(bS)+1/b]}$;

ΔA_j is the relative attenuation for filter j measured at normalized frequency $G^{[i/(bS)]}$;

ΔA_{j+1} is the relative attenuation for filter (j + 1) measured at normalized frequency for that filter $G^{[i/(bS)-1/b]}$.

7.2.4.4 The test shall be carried out from the filter with index j corresponding to the filter adjacent to the filter with the lowest midband frequency to the filter adjacent to the filter with the highest midband frequency in the set of filters.

7.2.4.5 For any filter bandwidth provided, the difference $\Delta P_j(\Omega_i)$ calculated according to formula (3), shall not exceed the acceptance limits given in 5.16 of IEC 61260-1:2014.

7.3 Linear operating range, measurement range, level range control and overload indicator

7.3.1 Linearity of the response of a filter resulting from changes in the level of the signal at the input shall be tested with steady sinusoidal signals with specified level and frequency. The linearity shall be measured at the exact midband frequency. The level linearity deviations shall be determined in accordance with 5.13 of IEC 61260-1:2014.

7.3.2 The level linearity shall be tested for three filters on each available level range. The filters shall be the filter with the lowest and the highest midband frequency in the set of filters and a filter in the middle of the frequency range selected by the laboratory performing the test.

7.3.3 The level range control shall be set to select the reference level range. The level of the input signal shall first be set to the specified reference input signal level. The corresponding output level shall be used for calculating the level linearity deviation for all input levels on any level range for the particular filter.

7.3.4 The test shall be performed for levels from the specified lower boundary of the specified linear operating range up to a level where the overload indicator displays an overload. Adjust the level of the input signal with steps that are not greater than 5 dB. The difference between successive steps of the input signal level shall be reduced to 1 dB when the distance to the lower or upper boundaries of a linear operating range is less than 5 dB and when the level is above the upper boundary. The boundaries are as stated in the instructions manual for the filter. If no overload is displayed, the filter does not conform to the requirements.

7.3.5 The averaging time during a measurement shall be long enough to establish a stable indication considering the actual frequency and the influence of internally generated noise at low input signal levels so the uncertainty of the measurement is within the required maximum-permitted uncertainty.

7.3.6 The measured level linearity deviation shall not exceed the acceptance limits given in 5.13.3 and 5.13.4 in IEC 61260-1:2014 for all measured levels between the lower boundary of the linear operating range for the appropriate level range as stated in the instructions manual for the filter, and up to the highest level, measured as described above, without an overload indication.

7.3.7 An overload shall not be indicated if the level of the input signal is below the stated upper boundary of the appropriate level range.

7.3.8 It shall be verified that the minimum time for presenting an overload is as specified in 5.17.3 in IEC 61260-1:2014.

7.3.9 For bandpass filters with a device that displays time-averaged output signal levels, time-integrated band levels, maximum levels, or displays stored results, it shall be verified that an overload is displayed if an overload condition occurred during any part of the measurement duration and that the indication remain displayed until the measurement result is reset.

7.3.10 Repeat the test for all available level ranges for the selected filters.

7.4 Time-invariant operation

7.4.1 If the instruction manual specifies that the filter performs time-invariant operation, the time-invariant operation of the filter shall be demonstrated by a swept-frequency test as described in 5.14 in IEC 61260-1:2014. The test shall be conducted on the reference level range. The level of the input signal shall be 3 dB less than the upper boundary of the linear operating range on the reference level range.

7.4.2 The sweep shall start at the frequency, f_{start}, less than the lowest bandedge frequency and where the relative attenuation of a filter is at least 55 dB and ends at a frequency, f_{end}, greater than the highest bandedge frequency and where the relative attenuation of the filter is again at least 55 dB.

7.4.3 For bandpass filters consisting of a set of filters with different midband frequencies, the measurement may be performed as one sweep covering all filters in the set. f_{start} is then less than the lowest bandedge frequency for the filter with the lowest midband frequency in the set and where the relative attenuation for this filter is at least 55 dB. f_{end} is then greater than highest bandedge frequency for the filter with the highest midband frequency and where the relative attenuation of this filter is at least 55 dB.

7.4.4 The time-averaged level of the output signal is measured for an averaging time, T_{avg}, which starts no later than the time when the sweep frequency is less than the lowest midband frequency and where the relative attenuation of a filter is at least 55 dB, and ends at a time not less than when the sweep frequency is greater than the highest midband frequency where the relative attenuation of the filter is again at least 55 dB. The averaging time shall be sufficiently long to also contain parts of the output signal delayed by the operation of the filter.

7.4.5 The measured time-average or equivalent-continuous output signal level for each filter in the set shall be compared with the calculated value, L_{c}, given in Formula (17) in IEC 61260-1:2014. The difference shall be less than or equal to the acceptance limit given in 5.14.3 in IEC 61260-1:2014.

NOTE 1 The informative Annex B gives an example for selecting adequate start and end frequency, sweep rate and averaging times.

Both the amplitude and the sweep-rate shall be considered when the uncertainty of measurement is calculated. Some commercial sweep generators approximate an exponential sweep by a piecewise linear sweep giving large deviations from the calculated results, while others demonstrate a constant exponential sweep rate within small tolerances. The exponential sweep signal may be generated by playing a calculated signal through a digital-to-analogue converter with known and verified specifications. See the informative Annex A for further information.

7.5 Power supply check

7.5.1 For instruments that require a battery power supply, a suitable power source with an adjustable supply voltage shall be substituted for the battery. The filter shall first be tested at the nominal voltage specified in the instructions manual with a sinusoidal input signal corresponding to the reference level on the reference range and at the exact midband frequency in a filter selected by the laboratory performing the test. The output level for the filter with a midband frequency corresponding to the frequency of the test signal shall be noted.

7.5.2 The test shall be repeated with the power supply delivering the maximum voltage specified in the instructions manual, and then with the power supply delivering the voltage just above the voltage before the means to check the power supply indicates that the voltage is too low. The largest difference between any two of the three observations of the output level shall not exceed the acceptance limits given in 5.21 in IEC 61260-1:2014.

8 Electromagnetic and electrostatic compatibility requirements

8.1 General

The environmental conditions of temperature and humidity during testing according to Clause 8 shall be recorded.

8.2 Influence of electrostatic discharges

8.2.1 The equipment required to determine the influence of electrostatic discharges on the operation of a filter shall conform to the specifications given in Clause 6 of IEC 61000-4-2:2008. The test set-up and test procedure shall be in accordance with the specifications given in Clauses 7 and 8 of IEC 61000-4-2:2008.

8.2.2 Electrostatic discharge tests shall be conducted with the filter operating and set to have the least immunity to electrostatic discharge, as determined by preliminary testing. If the filter can be fitted with connection devices that are not required for the configuration of the normal mode of operation as specified in the instructions manual, then no cables shall be fitted during the electrostatic discharge tests.

8.2.3 Discharges of electrostatic voltages shall not be made to electrical connector pins that are recessed below the surface of a connector or below the surface of the case of the filter.

8.2.4 Electrostatic discharges of the greatest positive and greatest negative voltage specified in 5.23.2.1 of IEC 61260-1:2014 shall be applied ten times by contact and ten times through the air. Discharges shall be applied to any point on the filter that is considered appropriate by the testing laboratory. The points shall be limited to those that are accessible during normal usage. If user access is required to points inside the filter, those points shall be included, unless the instructions manual prescribes precautions against damage by electrostatic discharges during this access. Care should be taken to ensure that any effects of a discharge to the filter under test are fully dissipated before repeating the application of a discharge.

8.2.5 After a discharge, the filter shall return to the same operating state as before the discharge. Any data stored before the discharge shall be unchanged after the discharge. Unquantified changes in the performance of the filter are permitted when a discharge is applied.

8.3 Influence of AC power-frequency and radio-frequency fields

8.3.1 Input signal

No input signal shall be applied, and the input terminal shall be connected to signal ground or a terminating resistance if so specified in the instructions manual for the filter.

8.3.2 Range setting

If the filter has more than one level range, the reference level range shall be selected.

8.3.3 AC power-frequency tests

8.3.3.1 Tests for the influence of AC power-frequency fields shall use a device capable of producing an essentially uniform root-mean-square magnetic field strength of 80 A/m. The device shall permit immersion of the complete filter, or the relevant components designated in the instructions manual, in the magnetic field. The frequency of the alternating magnetic field shall be 50 Hz or 60 Hz. The expanded uncertainty for measurements of magnetic field strength shall not exceed 8 A/m.

8.3.3.2 The filter under test shall be oriented as specified in the instructions manual for least immunity to an AC power-frequency field.

8.3.3.3 The level of the output signal in each band shall be recorded and verified to be below the limit specified in 5.23.3.9 of IEC 61260-1:2014. The duration of exposure shall be at least 10 s.

8.3.4 Radio-frequency tests

8.3.4.1 The equipment required to determine the influence of radio-frequency fields on the operation of a filter shall conform to the specifications in Clause 6 of IEC 61000-4-3:2006. The characteristics of suitable facilities for testing immunity to radio-frequency fields are given in Annex C of IEC 61000-4-3:2006. Antennas for generating radio-frequency fields are described in Annex B of IEC 61000-4-3:2006. The uniformity of the radio-frequency fields in the test facility shall be determined by the procedure given in 6.2 of IEC 61000-4-3:2006. The test set-up and test procedure shall be in accordance with the specifications given in clauses 7 and 8 of IEC 61000-4-3:2006.

8.3.4.2 Tests for the influence of radio-frequency fields shall be conducted with the filter set to the normal mode of operation as stated in the instructions manual. The filter shall be oriented in the direction with minimum immunity to radio-frequency fields.

NOTE If the filter is based on digital processing of digitized samples of the input signal, it will be unlikely that the immunity to radio-frequency fields will change with the bandwidth of the filter as long as the modulation frequency is equal to a midband frequency. For such filters, it will therefore be sufficient to test the immunity at one bandwidth only, selected by the laboratory performing the test.

8.3.4.3 If the filter has any connection device that permits the attachment of interface or interconnection cables, the influence of radio-frequency fields shall be tested with cables connected to all available connection devices. The lengths of the cables shall be as recommended in the instructions manual. All cables shall be unterminated and arranged as described in 7.3 of IEC 61000-4-3:2006 unless the manufacturer of the filter also supplies the device that is connected to the filter by a cable. In the latter event, the influence of radio-frequency fields shall be determined with all items connected together.

8.3.4.4 In accordance with IEC 61000-4-6:2013, for group Z hand-held filters, during the tests of the influence of radio-frequency fields, an artificial hand shall be placed around the hand-held accessories or keyboard, as required.

8.3.4.5 The root-mean-square electric field strength (when un-modulated) and modulation frequency shall be as specified in 5.23.3.2 of IEC 61260-1:2014. The carrier frequency of the modulated signal shall be varied in increments of up to 4 % over the range from 27 MHz to 500 MHz. The interval shall be up to 2 % for frequencies from 500 MHz to 1 GHz and for frequencies from 1,4 GHz to 2,7 GHz. The limits of the 95 % coverage interval around a measurement of root-mean-square electric field strength shall be not less than –0 % or greater than +40 % of the target radio-frequency electric field strength.

NOTE A frequency increment of 2 % or 4 % means that the next signal frequency is greater than the previous signal frequency by a factor of 1,02 or 1,04, respectively. Although carrier frequency increments of 1 % are specified in IEC 61000-4-3:2006, frequency increments of up to 2 % and up to 4 % are considered appropriate for the purposes of this Standard.

8.3.4.6 At each carrier frequency, the level of the output signal shall be recorded and verified to not exceed the limit specified in IEC 61260-1:2014, 5.23.3.10.

8.3.4.7 If the instructions manual states that the filter conforms to the specifications given in IEC 61260-1:2014 for electric field strengths greater than that specified in IEC 61260-

1:2014, then all tests for the influence of radio-frequency fields shall be repeated for the greatest of those electric field strengths.

8.3.4.8 Testing at the discrete frequencies, as specified above, does not eliminate the requirement to conform to the specifications given in IEC 61260-1:2014 at all carrier frequencies within the range specified in IEC 61260-1:2014. Tests shall be performed at other carrier frequencies if there are indications that the acceptance limits given in IEC 61260-1:2014 might be exceeded at carrier frequencies between any two successive frequencies.

8.3.4.9 Maintaining the configuration described above, the tests for the influence of radio-frequency fields shall be repeated to measure the influence of radio-frequency fields in at least one other plane. The other plane shall be approximately orthogonal to the principal plane of the previous orientation, within the limits of positioning for the test fixture.

8.3.4.10 When a radio-frequency field is applied, the filter shall remain operational and in the same configuration as before the radio-frequency field was applied.

8.3.4.11 For group Y or group Z filters, additional tests described in Table 4 of IEC 61000-6-2:2005 shall be performed to verify conformance to the specifications of IEC 61260-1:2014 for immunity to radio-frequency interference at AC input and output ports. The limits of the 95 % coverage interval around a measurement of root-mean-square electric field strength shall be not less than –0 % or greater than +40 % of the target radio-frequency electric field strength.

8.3.4.12 For group Z filters utilizing or specifying interconnecting cables longer than 3 m, the additional tests described in Table 2 of IEC 61000-6-2:2005 shall be performed to verify conformance to the specifications given in IEC 61260-1:2014 for the immunity of signal and control ports to radio-frequency interference. The limits of the 95 % coverage interval around a measurement of the AC power-supply voltage shall be not less than –0 % or greater than +5 % of the target voltage.

8.4 Radio-frequency emissions and public power supply disturbances

8.4.1 Radio-frequency field-strength emission levels, in decibels relative to 1 μV/m, shall be measured by the method of CISPR 16-2-3. The quasi-peak-detector instrument shall be as specified in CISPR 16-1-1 for the frequency ranges specified in IEC 61260-1:2014.

8.4.2 Measuring receivers, antennas, and test procedures shall be as specified in Clause 10 of CISPR 22:2008. All emission levels shall conform to the specifications given in IEC 61260-1:2014. Radio frequency emission tests shall be conducted with the filter operating, powered by its preferred supply, and set to the mode and level range, as stated in the instructions manual, that produce the greatest radio-frequency emission levels.

8.4.3 All fixtures and fittings used to maintain the position of the filter shall have negligible influence on the measurement of radio-frequency emissions from the filter.

8.4.4 Radio-frequency emission levels shall be measured over the frequency ranges specified in IEC 61260-1:2014 in an orientation chosen by the testing laboratory.

8.4.5 The radio-frequency emission levels shall be measured in one other plane chosen by the testing laboratory. The other plane shall be approximately orthogonal to the first orientation.

8.4.6 If the filter has any connection device that permits attachment of interface or interconnection cables, radio-frequency emission levels shall be measured with cables connected to all available connection devices. The length of the cables shall be the maximum recommended in the instructions manual. All cables shall be unterminated and arranged as described in 8.2 of CISPR 22:2008 unless the manufacturer of the filter also supplies the device connected to the filter by a cable. In this latter case, the radio-frequency emission levels shall be measured with all items connected together.

8.4.7 For a group Y or group Z filter that is operated from a public power supply, the disturbance to the public power supply shall be measured as described in Clause 9 of CISPR 22:2008. The method of measuring the disturbance caused by conducted emissions shall be as given in CISPR 16-1-2 and CISPR 16-2-1. For these tests, the filter shall be set to the reference level range unless the instructions manual specifies another level range. The filter shall conform to the specifications given in IEC 61260-1:2014 and to the limits given in 5.23.4.2 of IEC 61260-1:2014 for conducted disturbances.

9 Sensitivity to ambient air temperature and relative humidity

9.1 Tests shall be carried out to ensure that the filter satisfies the requirements for the range of ambient air temperatures and humidity given in section 5.22 in IEC 61260-1:2014. The exposure time at each ambient temperature shall be long enough to permit the instrument under test to reach equilibrium with the prevailing temperature and humidity.

9.2 The filter shall be permitted to acclimatize at the reference environmental condition for at least 6 h.

9.3 For all test conditions other than reference conditions, the filter shall be permitted to acclimatize for at least 4 h, unless the testing laboratory has applicable evidence that a shorter acclimatization period is sufficient. Rapid changes in air temperature and humidity leading to condensation shall be avoided.

9.4 The filter shall not be powered during the acclimatization period.

9.5 The output level on the reference range shall be measured with a sinusoidal input signal with a level equal to the reference level. Three filters shall be tested at the exact midband frequency: The filters shall be the filter with the lowest and the highest midband frequency in the set of filters and a filter in the middle of the frequency range selected by the laboratory performing the test. The tests shall also be repeated for the same filters for an input level 40 dB below the reference level.

9.6 The response to air temperature and relative humidity shall be measured at four combinations of temperature and relative humidity. The filter shall first be tested at the reference environmental conditions. The output level shall be recorded. The test shall be repeated with the following conditions:

- 50 % relative humidity and the minimum temperature;
- 50 % relative humidity and the maximum temperature; and
- 90 % relative humidity and the maximum applicable temperature for this humidity.

The deviation between the actual air temperature and the temperature specified, extended by the actual expanded uncertainty of measurement, shall not be more than ± 2 °C.

9.7 The deviation between the actual relative humidity and the relative humidity specified, extended by the actual expanded uncertainty of measurement, shall not exceed ± 5 %. Care shall be applied to prevent condensation.

9.8 The deviations of the output level indicated at the listed combinations of temperature and humidity, from the output level indicated at the reference temperature and humidity shall not exceed the required acceptance limits given in 5.22.2.3 of IEC 61260-1:2014.

10 Pattern-evaluation report

10.1 For each bandpass filter that is tested, the pattern-evaluation report shall give full details of the configuration that was tested including accessories that were installed, orientation of the filter during test of electromagnetic emission and susceptibility, test conditions including environmental conditions and test results.

10.2 Each test result shall give the measured deviation from the design goal and the associated actual expanded uncertainty of measurement along with an indication of conformance or non-conformance.

10.3 The test report shall state that the model of the bandpass filter conforms to, or does not conform to, the mandatory specifications of IEC 61260-1:2014 for the stated performance class and hence whether the pattern for the model of the filter is, or is not, approved. If the model of the bandpass filter is pattern approved, notice of such approval should be made publicly available for use during subsequent periodic tests.

10.4 The test information noted in Clause 10 of IEC 61000-4-3:2006 shall be included in the test report. The report shall describe any temporary degradation in performance, loss of function, or loss of data noted at the end of a series of tests with electrostatic discharges, AC power frequency fields, or radiofrequency fields.

Annex A
(informative)

Uncertainty related to test by sinusoidal sweeps

A.1 General

A.1.1 A constant-amplitude sinusoidal signal with a frequency increasing at an exponential rate is required for the test to demonstrate time-invariant operation. The uncertainty in measured output level will depend on the uncertainty in the amplitude and the uncertainty in the sweep rate. This informative annex gives information of how the uncertainties in the test signal may be obtained.

A.1.2 If a close approximation to an exponential sweep with a constant amplitude sinusoidal signal from a lower frequency, f_{start}, to a higher frequency f_{end} can be assumed, Formula (17) in IEC 61260-1:2014 may be used for the estimation of the uncertainty in the measured output level. The following symbols are used:

$u_{L_{\text{in}}}$ standard uncertainty of the input level L_{in} (amplitude);

$u_{T_{\text{sweep}}}$ standard uncertainty of elapsed time T_{sweep} (time) for the sweep from the start frequency, f_{start}, to the end frequency, f_{end};

$u_{T_{\text{avg}}}$ standard uncertainty of the averaging time, T_{avg} (time);

$u_{f_{\text{end}}}$ standard uncertainty of the end frequency for the sweep f_{end} (frequency);

$u_{f_{\text{start}}}$ standard uncertainty of the start frequency for the sweep f_{start} (frequency).

Additional uncertainties, such as uncertainty related to how close the sweep is to an exponential sweep, uncertainty related to the frequency, shape or distortion of the signal and uncertainty related to the adjustment and reading of the values, may apply.

A.1.3 The relation between the standard uncertainty $u_{L_{\text{c}}}$ in the output level, L_{c}, and the standard uncertainties defined above, may be found from the referred Formula (17) in IEC 61260-1:2014:

$$u_{L_C} = \left[\left(\frac{\partial L_{\text{C}}}{\partial L_{\text{in}}}\right)^2 \cdot u_{L_{\text{in}}}{}^2 + \left(\frac{\partial L_{\text{C}}}{\partial T_{\text{sweep}}}\right)^2 \cdot u_{T_{\text{sweep}}}{}^2 + \left(\frac{\partial L_{\text{C}}}{\partial T_{\text{avg}}}\right)^2 \cdot u_{T_{\text{avg}}}{}^2 + \left(\frac{\partial L_{\text{C}}}{\partial f_{\text{end}}}\right)^2 \cdot u_{f_{\text{end}}}{}^2 + \left(\frac{\partial L_{\text{C}}}{\partial f_{\text{start}}}\right)^2 \cdot u_{f_{\text{start}}}{}^2 \right]^{1/2} \text{dB} \qquad \text{(A.1)}$$

This may be simplified to:

$$u_{L_{\text{C}}} = \left[u_{L_{\text{in}}}{}^2 + \left(\frac{10}{\ln(10)}\right)^2 \times \left(\frac{u_{T_{\text{sweep}}}}{T_{\text{sweep}}}\right)^2 + \left(\frac{10}{\ln(10)}\right)^2 \times \left(\frac{u_{T_{\text{avg}}}}{T_{\text{avg}}}\right)^2 + \left(\frac{10}{\ln\left(f_{\text{end}}/f_{\text{start}}\right) \times \ln(10)}\right) \times \left[\left(\frac{u_{f_{\text{end}}}}{f_{\text{end}}}\right)^2 + \left(\frac{u_{f_{\text{start}}}}{f_{\text{start}}}\right)^2 \right] \right]^{1/2} \text{dB}$$

(A.2)

A.2 Digitally generated signal

A.2.1 The sweep signal may be generated as a digital signal with a constant sampling frequency where each sample of the signal is computed by a mathematical operation with known uncertainty. The signal may be converted by a digital-to-analogue system to generate the required analogue test signal. The uncertainty in the test signal will then be the combined uncertainty in the mathematically generated digital signal, the uncertainty in the sampling frequency and the uncertainty in the digital-to-analogue converter.

A.2.2 The sampling frequency of the system may be verified by playing a mathematically generated signal with a known and constant frequency and measuring the frequency by a frequency counter. The uncertainty in the sweep rate will mainly be determined from the accuracy in the mathematically generated sweep and the uncertainty in the sampling frequency.

A.2.3 The amplitude uncertainty of the digital-to-analogue system may be measured with a mathematically generated signal with fixed frequency and known amplitude. The level of the signal may then be measured by a voltmeter. The amplitude uncertainty should be tested at all frequencies where high accuracy is relevant for the requested sweep. This will normally cover the combined frequency range for the lowest band-edge frequency to the highest band-edge frequency in the set of filters to be tested.

A digital sweep signal s_n with effective value 1,0 may be generated by the formula below where *n* is the sample number and f_s is the sampling frequency. *n* is then a sequence of whole numbers from zero up to the whole number closest to $f_\mathrm{s} \times T_\mathrm{sweep}$. The sweep rate, r, is given by:

$$r = \frac{1}{T_\mathrm{sweep}} \times \ln\left(\frac{f_\mathrm{end}}{f_\mathrm{start}}\right) \tag{A.3}$$

The samples may be calculated by the formula:

$$s_n = \sqrt{2}\,\sin\left(\frac{2\pi}{r} \times f_\mathrm{start} \times \left[\exp\left(\frac{r}{f_\mathrm{s}}n\right) - 1\right]\right) \tag{A.4}$$

A.3 Test signal from a signal generator

A.3.1 Signal generators able to generate a constant-amplitude sinusoidal signal with a frequency increasing at an exponential rate are available. However, some generators deliver only a crude approximation to the exponential sweep with an unknown uncertainty in the sweep rate. With sufficient information from the manufacturer of the generator, an uncertainty calculation as described in A.1 may be applied. If such information is not available, or the information is not suitable, the sweep rate and uncertainty in level has to be measured.

A.3.2 The test signal from the generator may be measured by a system where the signal is sampled at a known sampling frequency by an analogue-to-digital system with known uncertainty in measurement. By signal analysis of the recorded signal, the instantaneous level of the sweep signal and the instantaneous frequency and thus the sweep rate may be determined. See [1][1] for further information.

A.3.3 Some generators deliver the end frequency just before the sweep is started. This creates an unwanted transient, and such generators are therefore not regarded as suitable for the test.

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1 Numbers in square brackets refer to the Bibliography.

A.3.4 Some sweep generators may halt at the end frequency for a specified time before the sweep is ended and the frequency returned to the start frequency. This may be very convenient to prevent the return to the start frequency from disturbing the measurement.

A.3.5 The formula (A.2) may be used for the following example calculation for uncertainty in the test signal.

The input signal is measured to be constant within an uncertainty of 0,03 dB, and is adjusted by reading a display with resolution 0,1 dB. This gives

$$u_{L_{\text{in}}} = \sqrt{\left(0{,}1\,\text{dB} / 2\sqrt{3}\right)^2 + \left(0{,}03\,\text{dB}\right)^2} \approx 0{,}042\,\text{dB}$$

The following values and uncertainties are assumed:

$$T_{\text{sweep}} = 20\,\text{s} \qquad u_{T_{\text{sweep}}} = 0{,}05\,\text{s}$$

$$T_{\text{avg}} = 20\,\text{s} \qquad u_{T_{\text{avg}}} = 0{,}02\,\text{s}$$

$$f_{\text{end}} = 50\,000\,\text{Hz} \qquad u_{f_{\text{end}}} = 5\ \text{Hz}$$

$$f_{\text{start}} = 0{,}5\,\text{Hz} \qquad u_{f_{\text{start}}} = 0{,}05\,\text{Hz}$$

This gives $u_{L_{\text{C}}} \approx 0{,}057\,\text{dB}$ or an expanded uncertainty of the test signal of 0,115 dB.

If the result is indicated on a display which also has a resolution of 0,1 dB, this uncertainty has to be added. The expanded uncertainty of the displayed value will then be 0,128 dB. Some uncertainties may be added to account for the approximation to an exponential sweep and for repeatability.

A.4 Comparing measurements

If the filter is time-invariant, the effective bandwidth deviation may be measured by two methods: the exponential sweep method as described in this informative annex and the frequency-by-frequency measurement described in 7.2.3. The effective bandwidth deviations calculated from the results are expected to coincide within the uncertainty of measurement.

Annex B
(informative)

Test of time invariant operation with the use of an exponential sweep – Example

B.1 General

This example shows how an exponential sweep may be performed for verification of time invariant operation. The filters to be tested are assumed to be a set of one-third-octave bandpass filters in the range from 6,3 Hz to 20 kHz. The filters are contained in an integrating-averaging sound level meter, and the display device in the sound level meter is used for reading the averaged output level.

B.2 Example

B.2.1 A signal generator with verified performance is assumed to deliver the test signal. The output from the generator is coupled to the input terminal of the filter. The generator is set to deliver 1 volt at 1 kHz. The sound level meter/filter is set to the reference level range. The sensitivity of the sound level meter is adjusted to display 120 dB for this input level according to the assumed recommendations from the manufacturer. The sound level meter then displays signal levels in decibels relative to 1 μV. The upper boundary of the reference level range is assumed to be 130 dB. The sweep shall be performed at 3 dB below this level or at 127 dB re 1 μV.

B.2.2 The signal generator is set up for a sweep from 0,01 Hz to 1 MHz with the amplitude corresponding to the requested level 127 dB. This corresponds to a sweep range of 8 decades. The required sweep rate is 2 s to 5 s per decade. If the sweep time is set to 30 seconds, this corresponds to 3,75 seconds per decade. The signal generator allows the sweep to be started manually. Before the sweep is started, the generator delivers a signal with the frequency selected as the start frequency. When the sweep is ended, the frequency is immediately returned to the start frequency. This may create a deviation in the measured level if the transient from the return of the frequency is a part of the averaging period.

B.2.3 The sweep time in the generator and the averaging time for the sound level meter are both set to 30 s. The sweep is manually started about 0,5 s to 1,5 s after the integration in the sound level meter is started. Therefore the averaging is ended before the sweep is finished by the same amount of time. The sweep frequency when the averaging is finished will therefore be in the range 398 kHz to 736 kHz, which is well above the upper bandedge frequency 22,39 kHz for the filter with the highest midband frequency and also above the frequency where the attenuation is at least 55 dB. The transient when the sweep frequency is returned to the start frequency will, with these settings, be outside the averaging interval.

B.2.4 The expected output level, L_c, may be computed from Formula (17) in IEC 61260-1:2014.

$$L_\mathrm{C} = L_\mathrm{in} - A_\mathrm{ref} + 10\,\lg\left[\frac{T_\mathrm{sweep}}{T_\mathrm{avg}}\;\frac{\lg\left(f_2/f_1\right)}{\lg\left(f_\mathrm{end}/f_\mathrm{start}\right)}\right]\ \mathrm{dB} \tag{B.1}$$

where

L_in = 127 dB re 1 μV;

A_ref = 0 dB.

The ratio between the sweep time and averaging time is:

$$\frac{T_{\text{sweep}}}{T_{\text{avg}}} = \frac{30\,\text{s}}{30\,\text{s}} = 1 \qquad \text{(B.2)}$$

The ratio between the upper and lower bandedge frequency of the filter is for one-third-octave filter:

$$\frac{f_2}{f_1} = \frac{10^{0,05}}{10^{-0,05}} = 1,259... \qquad \text{(B.3)}$$

The ratio between the end frequency and the start frequency for the sweep is:

$$\frac{f_{\text{end}}}{f_{\text{start}}} = \frac{1\text{MHz}}{0,01\text{Hz}} = 10^8 \qquad \text{(B.4)}$$

This gives the following value for L_C:

$$L_C = 127\ \text{dB} - 19,03\ \text{dB} = 107,97\,\text{dB} \qquad \text{(B.5)}$$

B.2.5 The difference between the measured output level and the level L_C, calculated above, is regarded as the deviation in the test for time invariant operation and shall be below the acceptance limits given in 5.14 in IEC 61260-1:2014 in order to claim time invariant operation for the filter.

B.2.6 The one-third-octave filter with the lowest midband frequency will have the longest impulse-response. The averaging period will end 18 s to 20 s after the sweep frequency is equal to the lowest midband frequency, 6,3 Hz. Normally the tail of the impulse response for this filter will be very small when the averaging ends. If this is not the case, the test needs to be modified.

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[1] BORK, I., Exponential sweep check using Hilbert-Transform, *Acta Acustica united with Acustica*, 2014, vol. 100, p. 659-666.

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